

A photograph of a flooded vineyard. In the foreground, a large white pipe runs diagonally across the frame, partially submerged in muddy water. The pipe has some blue tape and dirt on it. To the left, there are dark metal structures, possibly part of a trellis system, with yellow caution tape tied around them. The background shows rows of grapevines in a field that is completely inundated with water. The sky is overcast with grey clouds.

# Data collection and Analysis on the Cosumnes Flood-MAR Vineyard

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OHWD Board Meeting  
October 18, 2022

# Extensive Collaboration Between Institutions

## University of California, Davis

- Laura Foglia and Helen Dahlke
  - Andrew Calderwood
  - Alisha Rodriguez
  - Brad T Gooch
  - Maribeth Kniffin
  - Elad Levintal
  - Cristina Prieto Garcia

## University of California, Santa Cruz

- Andrew Fisher
  - Jenny Pensky

## Lawrence Livermore National Laboratory

- Ate Visser
- Amanda Deinhart
- Erik Oerter

## California State University, Sacramento

- Amelia Vankeuren
  - 19 undergraduate students

# Extended Data Collection: Before and After flooding

- Continuous groundwater level and temperature
  - Evapotranspiration sensors
  - Soil moisture and infiltration data
  - 2 new stream gauges
  - Geological and geophysical information
  - Isotopes data
  - Water Quality Sampling
- Develop solid understanding of baseline condition

# Water quality monitoring

Dr. Amelia Vankeuren  
Sacramento State Geology

- Baseline groundwater and surface water sampling campaigns in 2019
- Water sampling during and after flooding in 2021



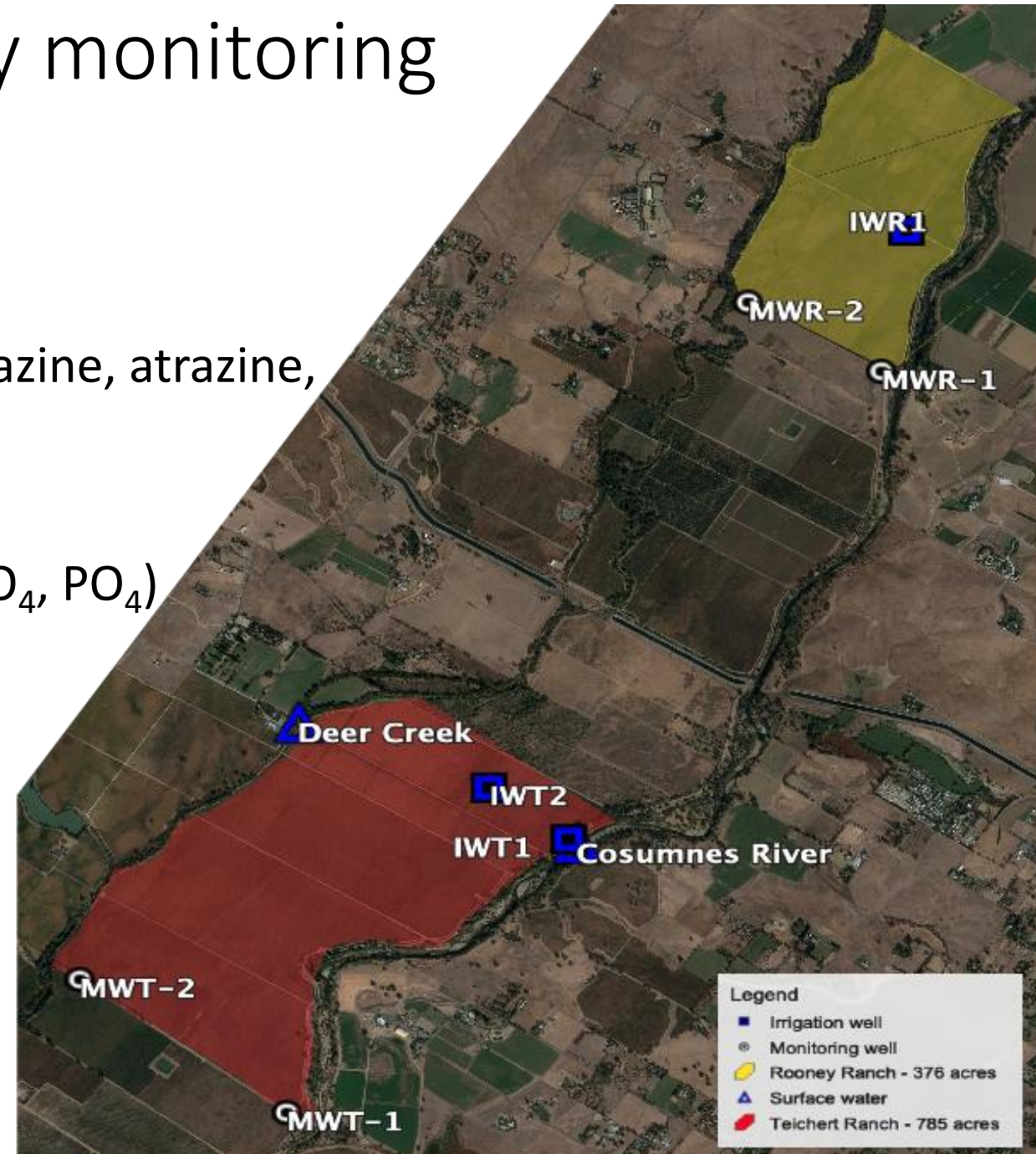
# Water quality monitoring

Water samples analyzed for:

- Nutrients (nitrogen, phosphorous)
- Herbicides (glyphosate, diquat/paraquat, simazine, atrazine, cyanazine, mecoprop)
- Pesticides (imidicloprid)
- Major ion chemistry (Ca, K, Mg, Na, DIC, Cl, SO<sub>4</sub>, PO<sub>4</sub>)
- Stable isotopes in water ( $\delta^{18}\text{O}$ ,  $\delta^2\text{H}$ )
- Trace elements (including As, U, Cr)

Samples collected from:

- 3 irrigation wells
- 4 monitoring wells
- Deer Creek
- Cosumnes River



# Water quality monitoring: results

Category	Potential contaminant	Maximum allowed in water (EPA MCL or human health reference level)	Highest measured concentration
Nutrients	Nitrate mg/L as N	10	4
	Phosphate mg/L		3
Herbicides	Glyphosate (Roundup)		Below detection
	Diquat/Paraquat		Below detection
	Simazine ug/L	17	0.007
	Cyanazine		Below detection
	Atrazine		Below detection
	Mecoprop		Below detection
Pesticide	Imidacloprid ug/L	283	0.002
Trace metals	Arsenic ug/L	10	2.5
	Uranium ug/L	30	0.3
	Chromium ug/L	50	2.0

No samples had contaminant levels exceeding water quality standards

# Water quality monitoring: future work

- Collect and analyze groundwater after significant flooding
- Evaluate changes in water chemistry
- Evaluate changes in potential contaminant levels
- Evaluate stable isotopes in water to determine contribution of Cosumnes River water to the aquifer



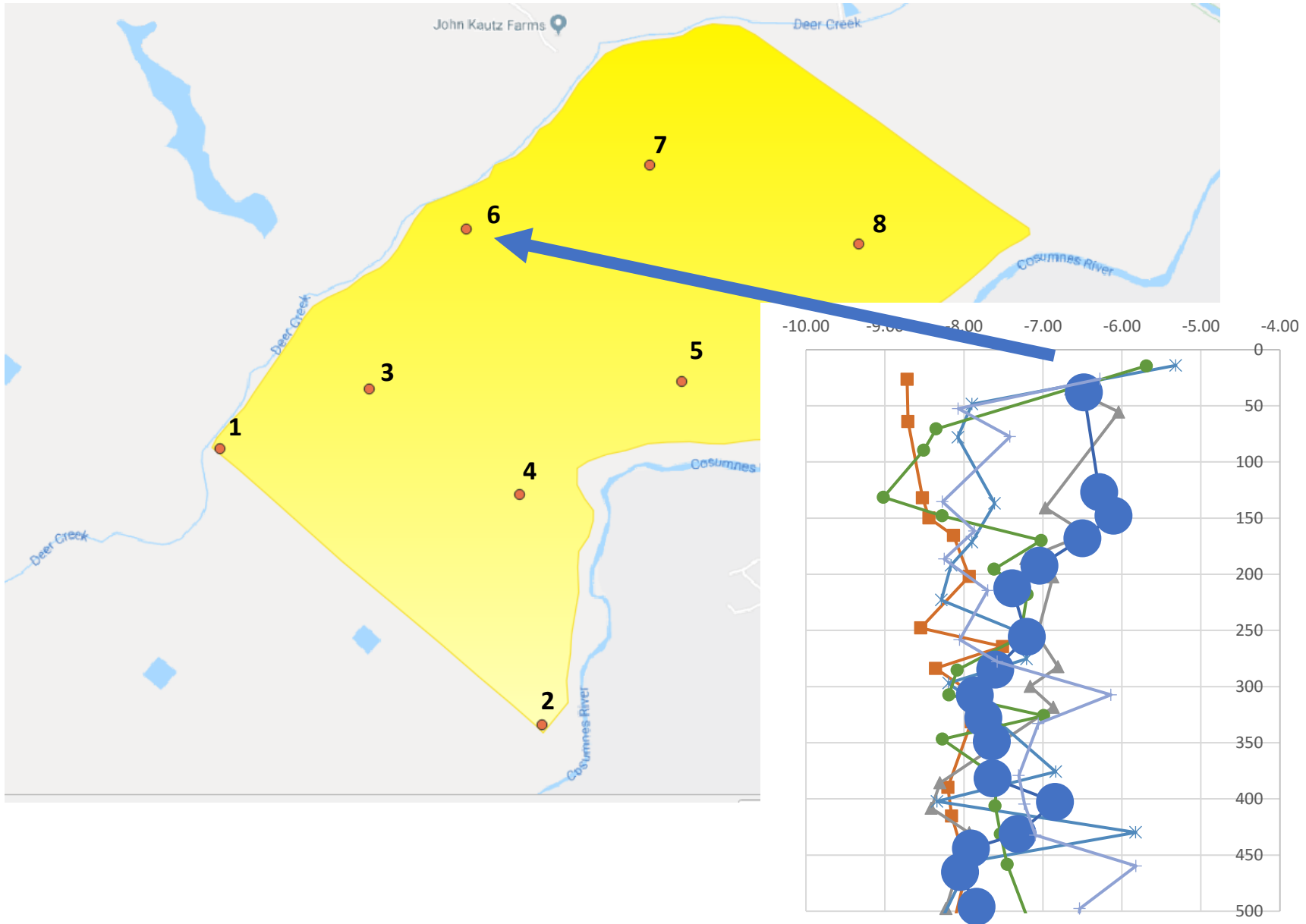
# Isotope Data

## Lawrence Livermore National Laboratory

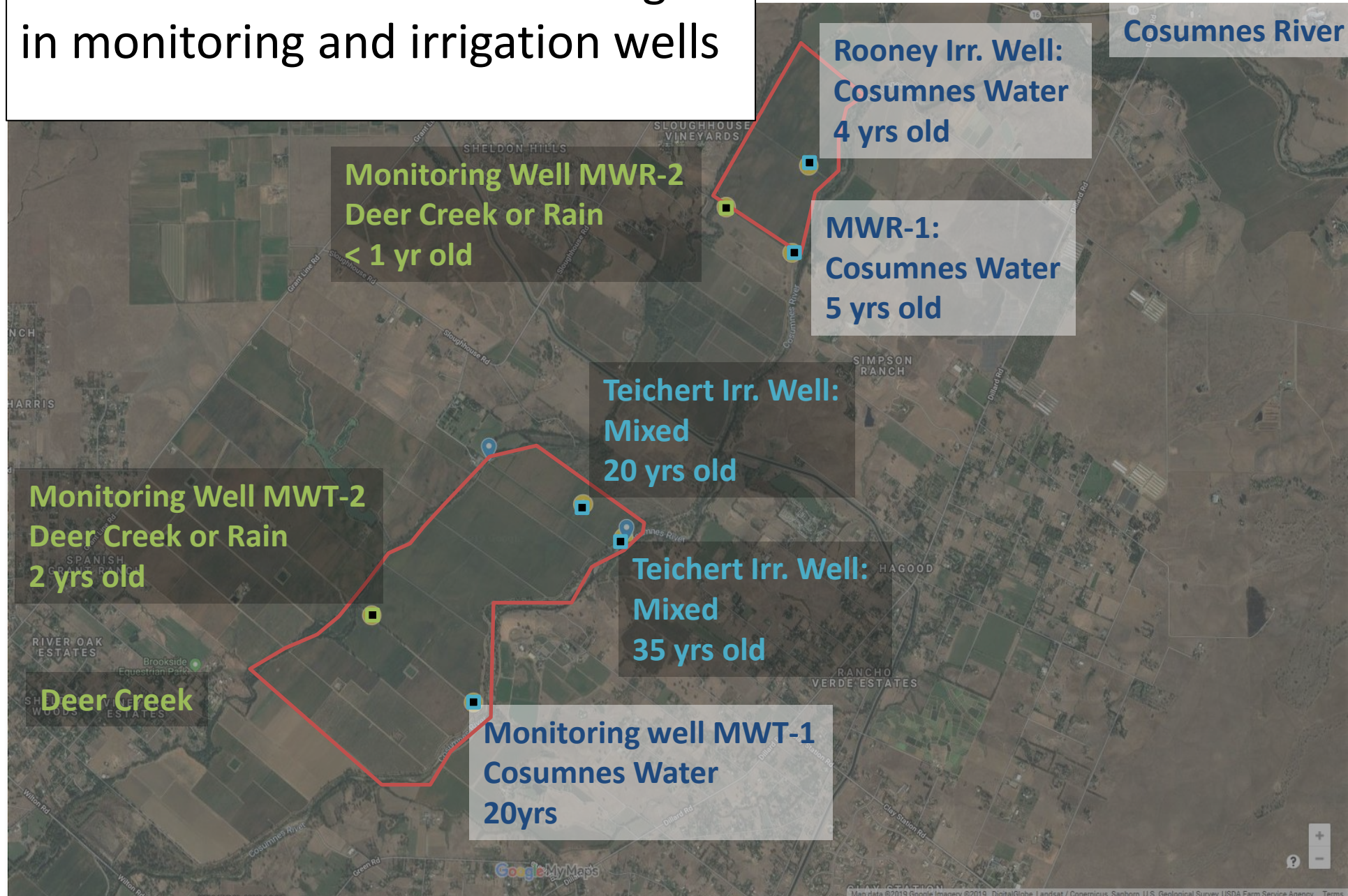
- Why?
- Study source of soil water and groundwater:  
“stable isotopes”: deuterium and oxygen-18
  - Rain: low elevation → “heavy”
  - Deer Creek: low elevation → “heavy”
  - Cosumnes River: high elevation → “light”
- Study groundwater flow velocities:  
“water age”: natural radioactive tritium decay
  - Unsaturated zone to water table
  - Groundwater flow



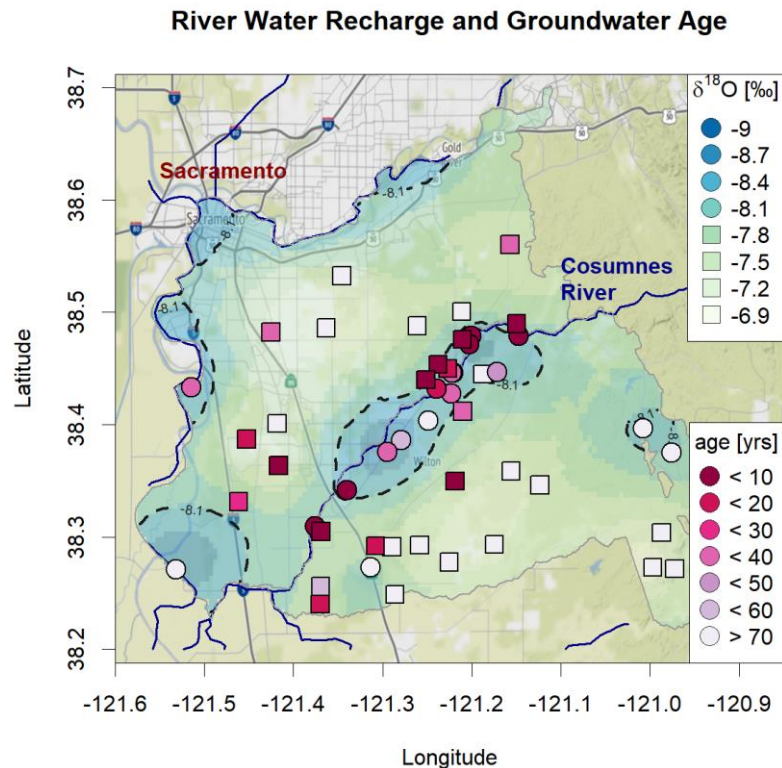
# Deer Creek infiltration in soil water stable isotopes



# Different water sources and ages in monitoring and irrigation wells

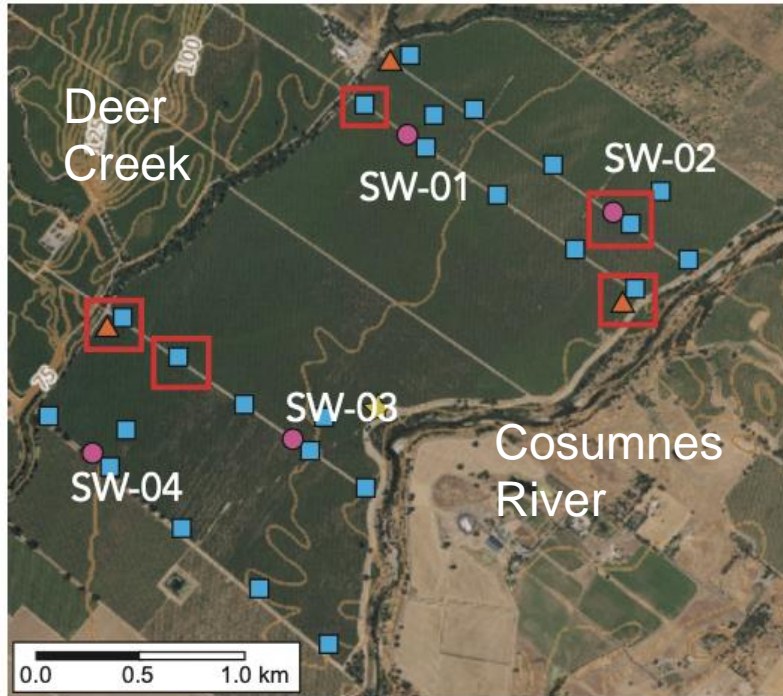


# Regional groundwater isotope analyses

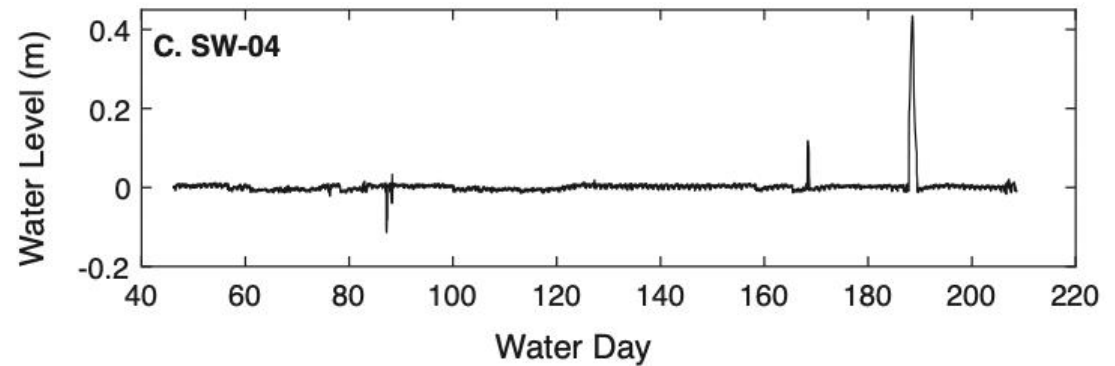
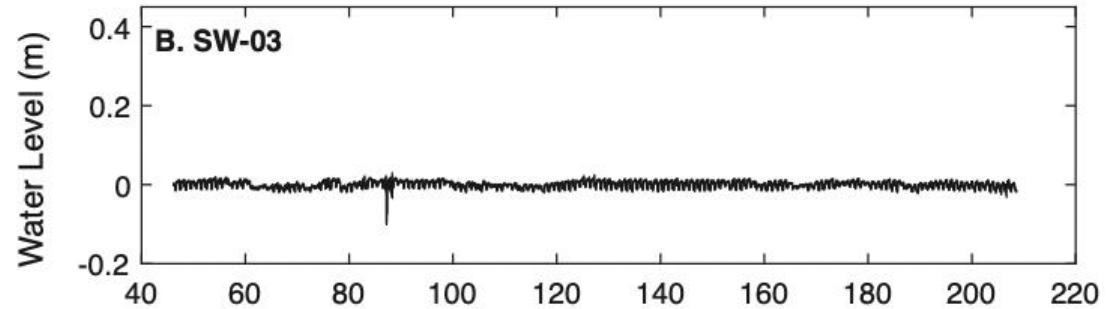
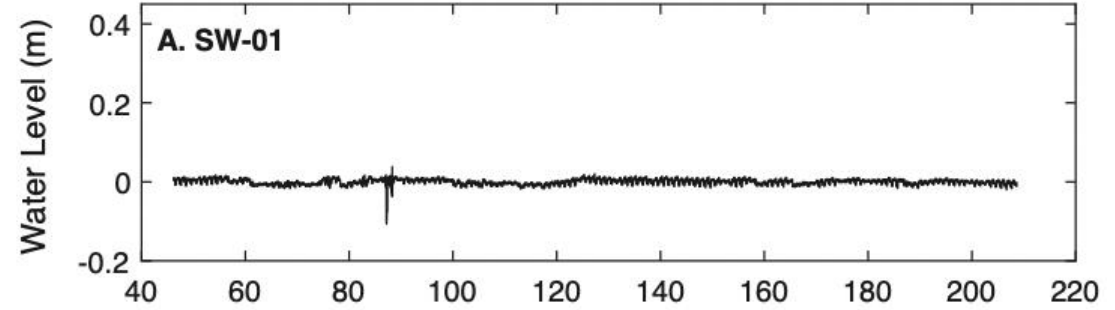


- Most young groundwater close to Cosumnes River and Deer Creek  
→ active recharge
- Older fossil water in regional groundwater basin  
→ no recharge

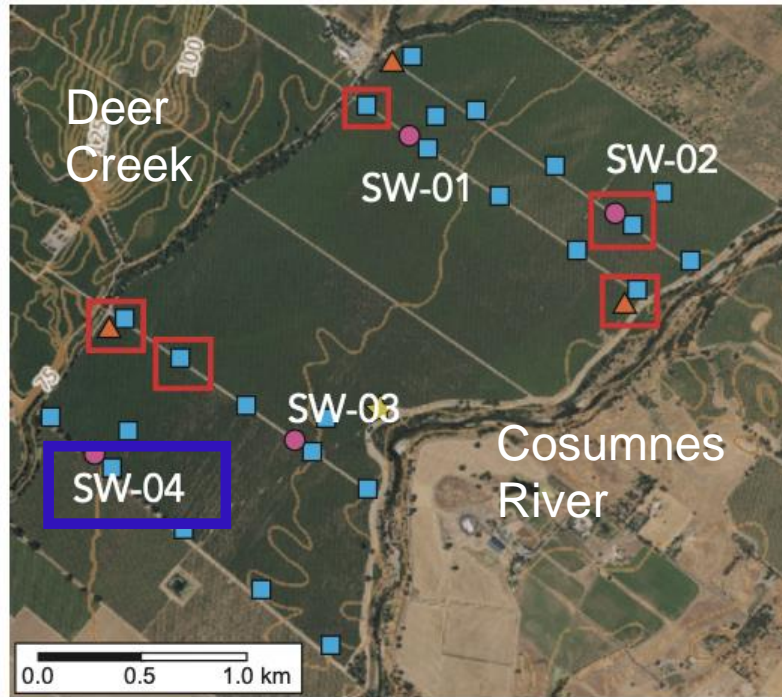
# Deer Creek flooded naturally in 2020



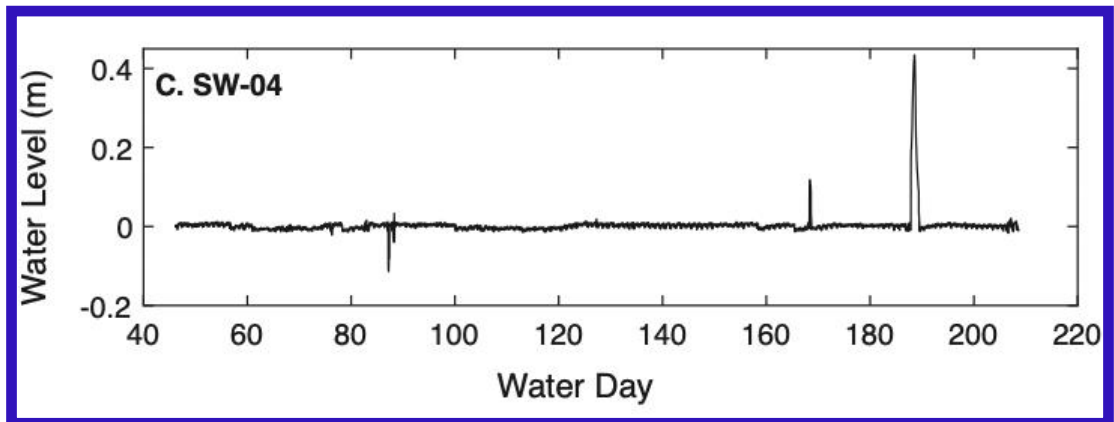
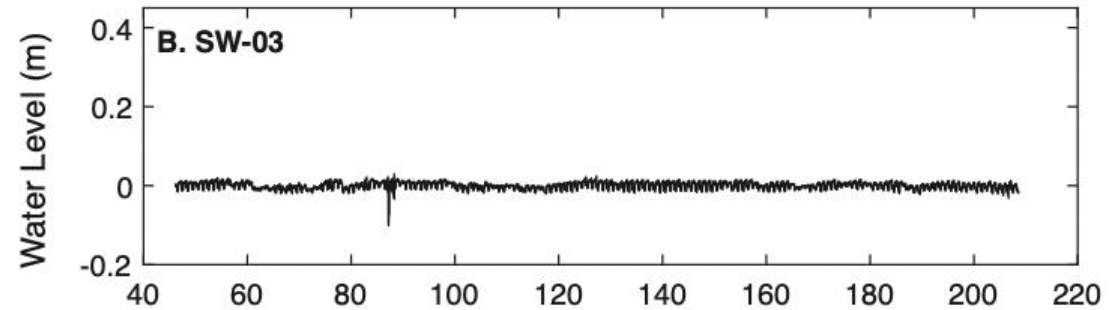
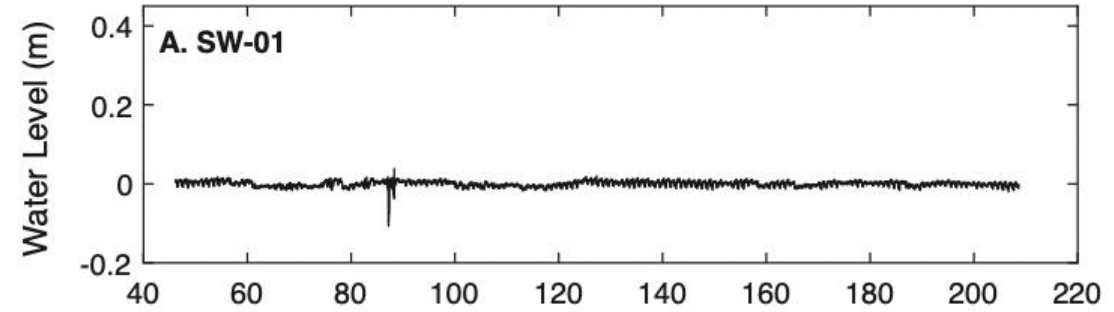
- Temperature probe, Sediment cup & tray
- Piezometer & Stilling well
- Piezometer
- Rain gauge, baro gauge, and timelapse camera
- Locations with apparent delivered sediment



# Water level ranged between 5-16 in above ground surface



- Temperature probe, Sediment cup & tray
- Piezometer & Stilling well
- Piezometer
- Rain gauge, baro gauge, and timelapse camera
- Locations with apparent delivered sediment



# Infiltration rates ranged between 0.5- 8 in/day

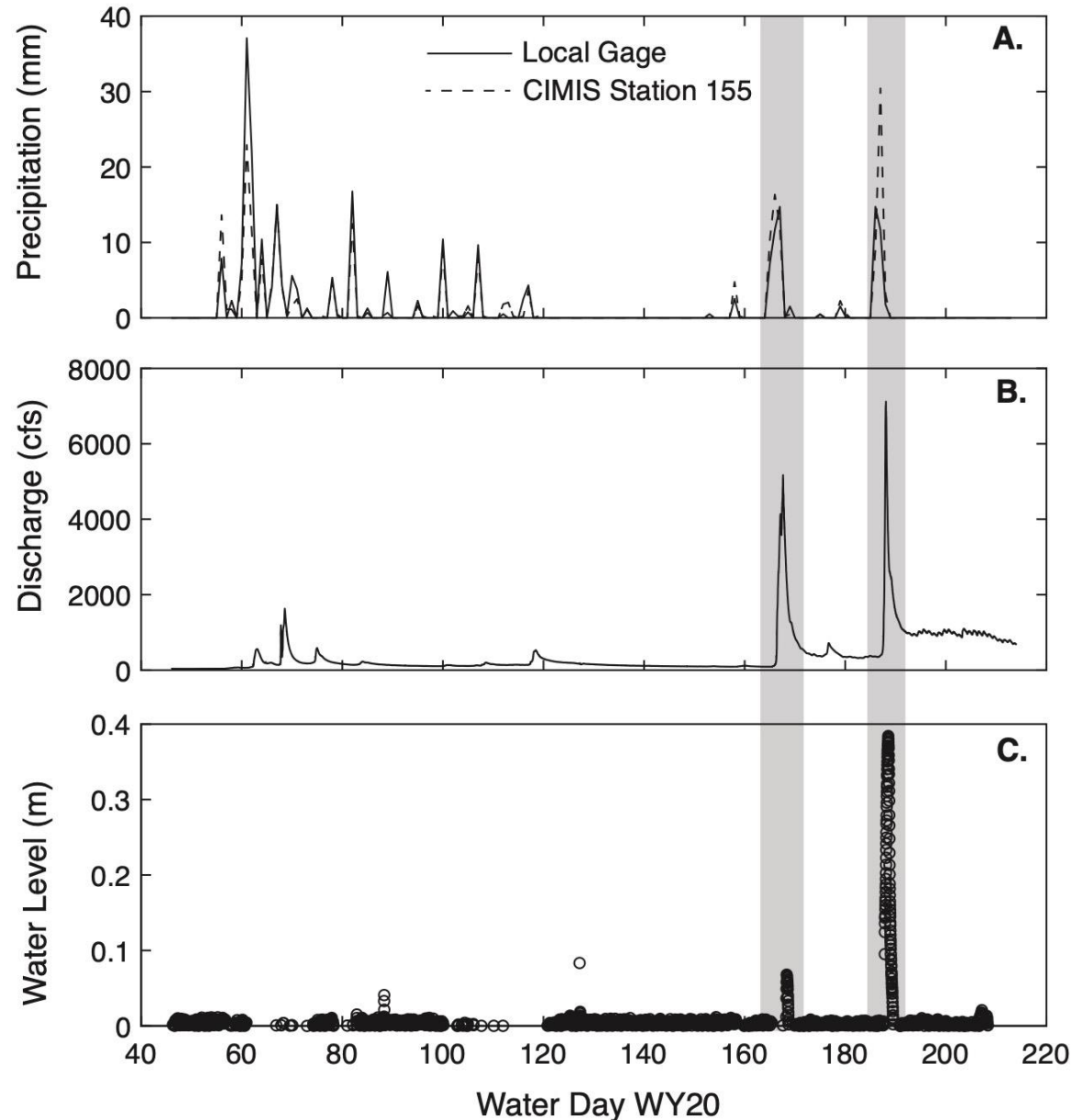
## Infiltration rates:

**Day 168:** 19 cm/day

**Day 169:** 11 cm/day

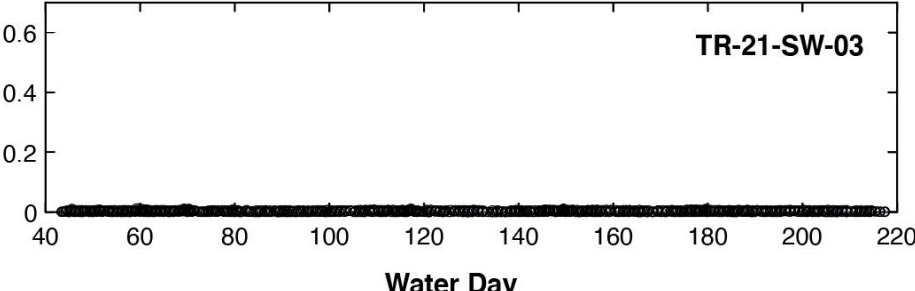
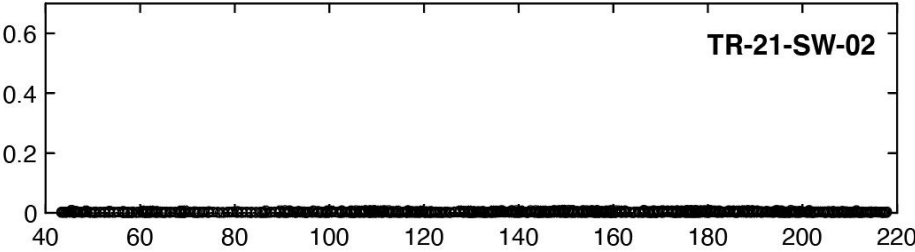
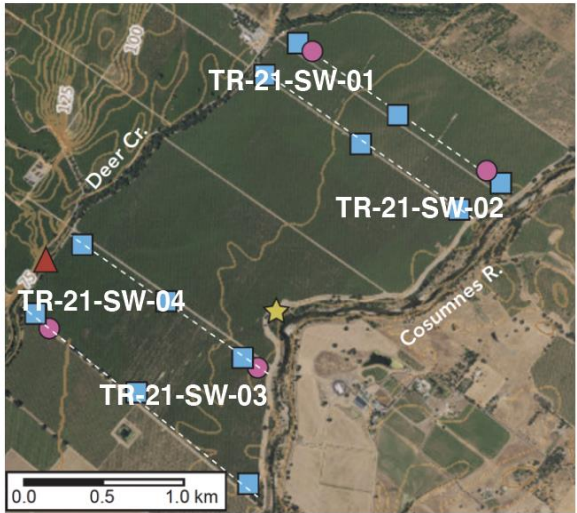
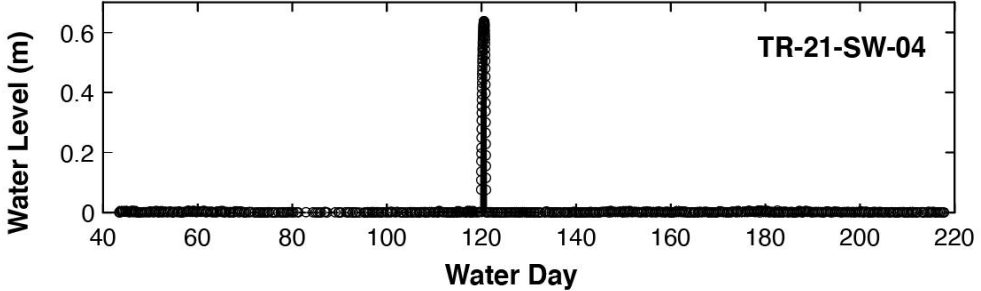
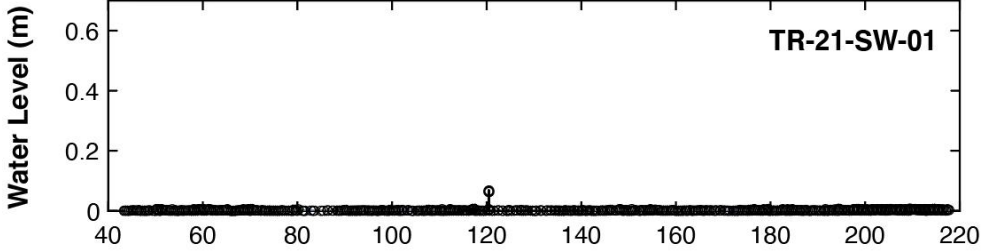
**Day 188:** 8 cm/day

**Day 189:** 1 cm/day

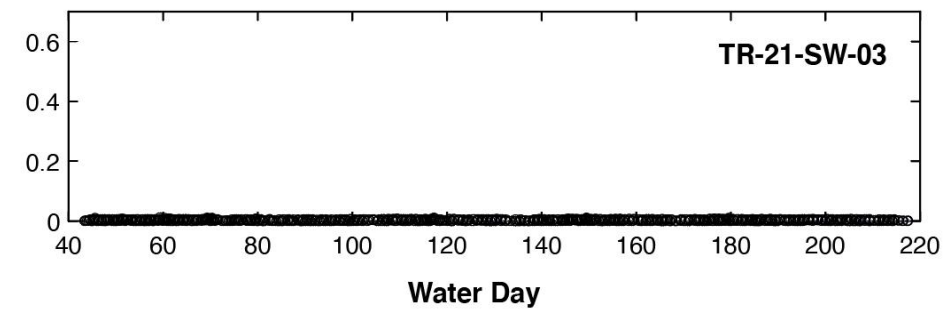
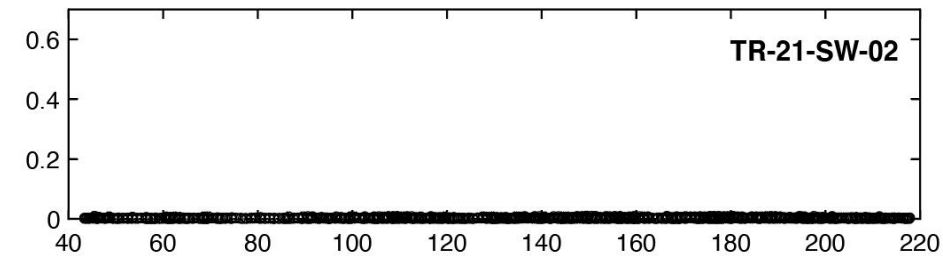
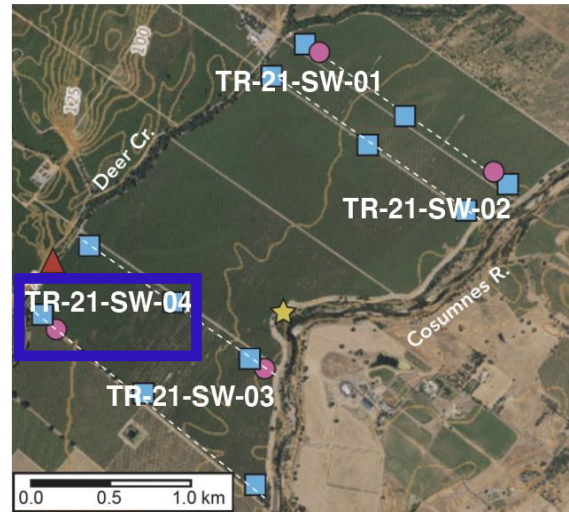
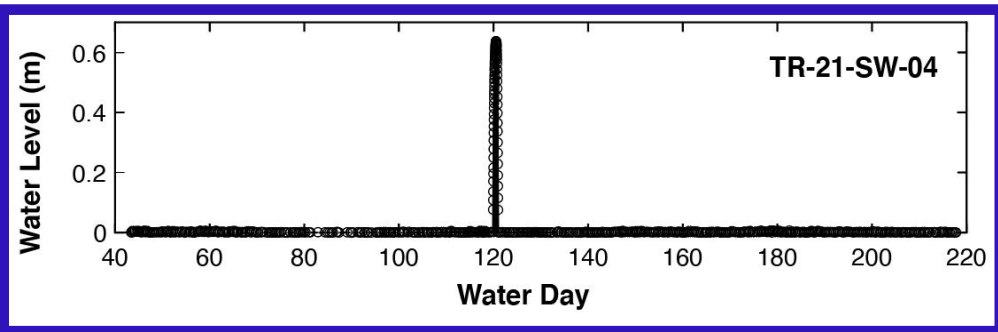
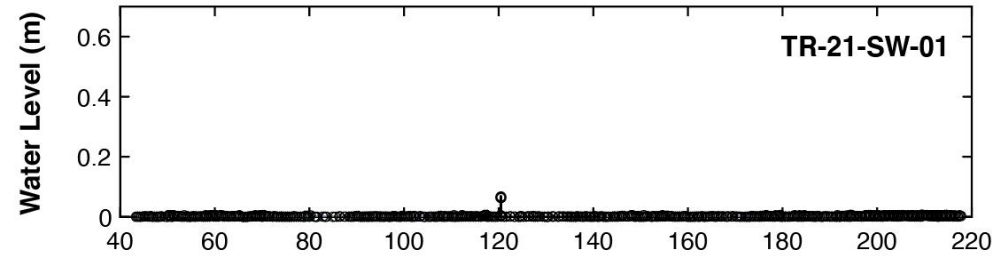


- Infiltration rates were higher during the first rain event, likely decreased due to sedimentation
- Likely a conservative estimate – a large fraction of infiltration occurs through macropores (i.e. plant roots, animal burrows)

# Managed flooding from the Cosumnes River in WY21



# Managed flooding from the Cosumnes River in WY21



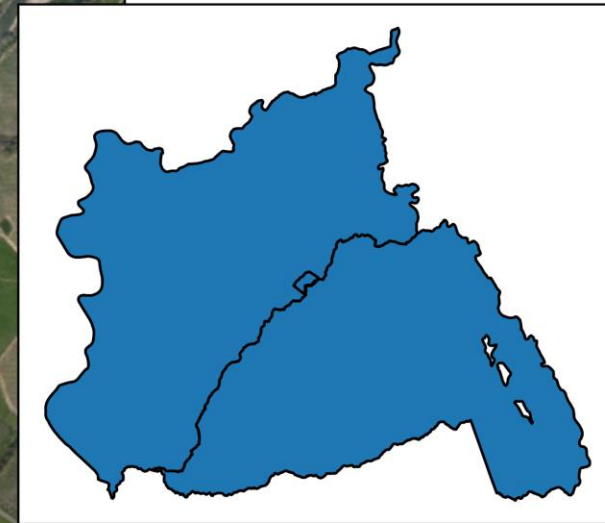
\* Upper ~45 cm of soil did not stay saturated long enough to measure seepage rates in WY21



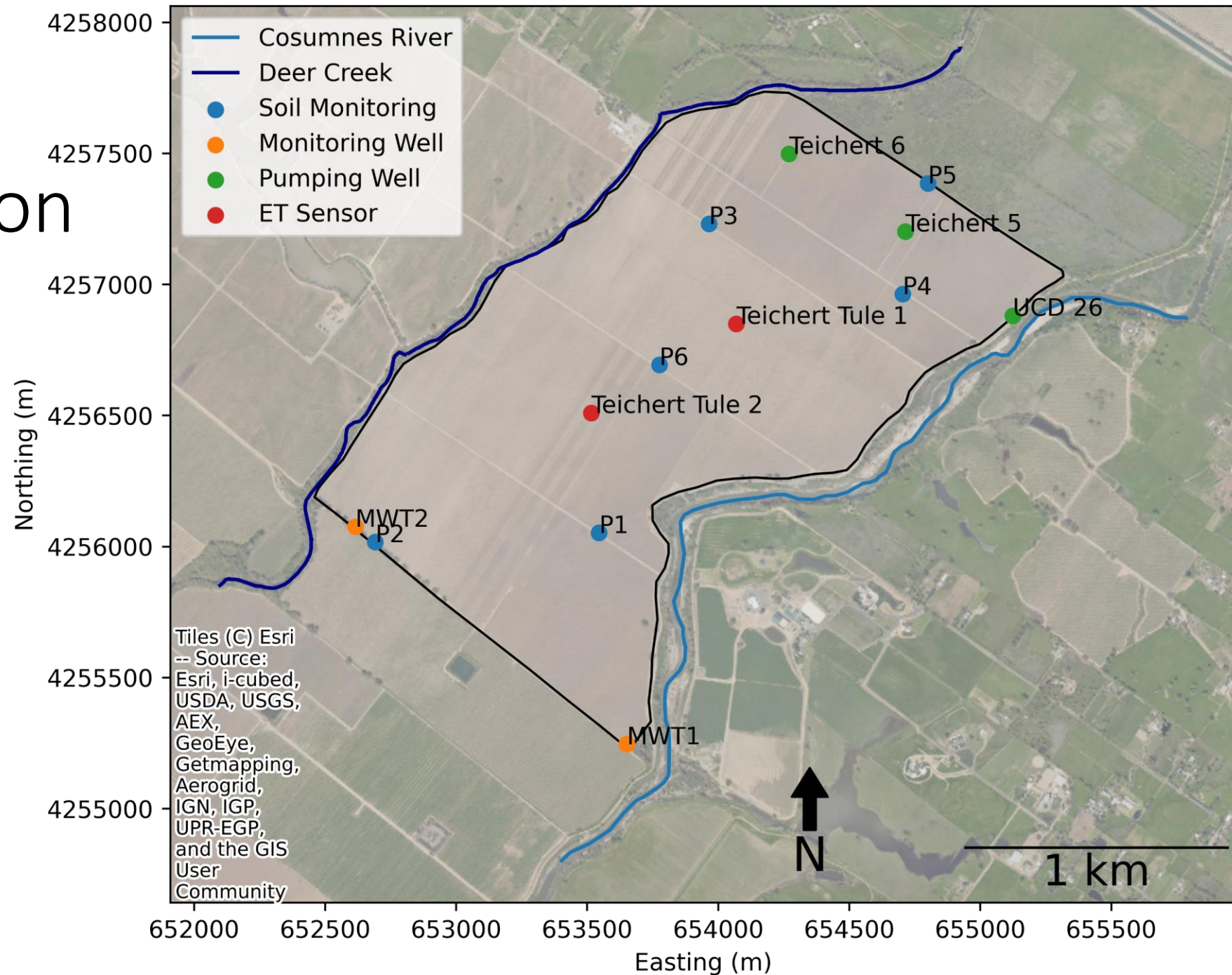
# More details on the actual 2021 flooding



Approximate flooding  
extent

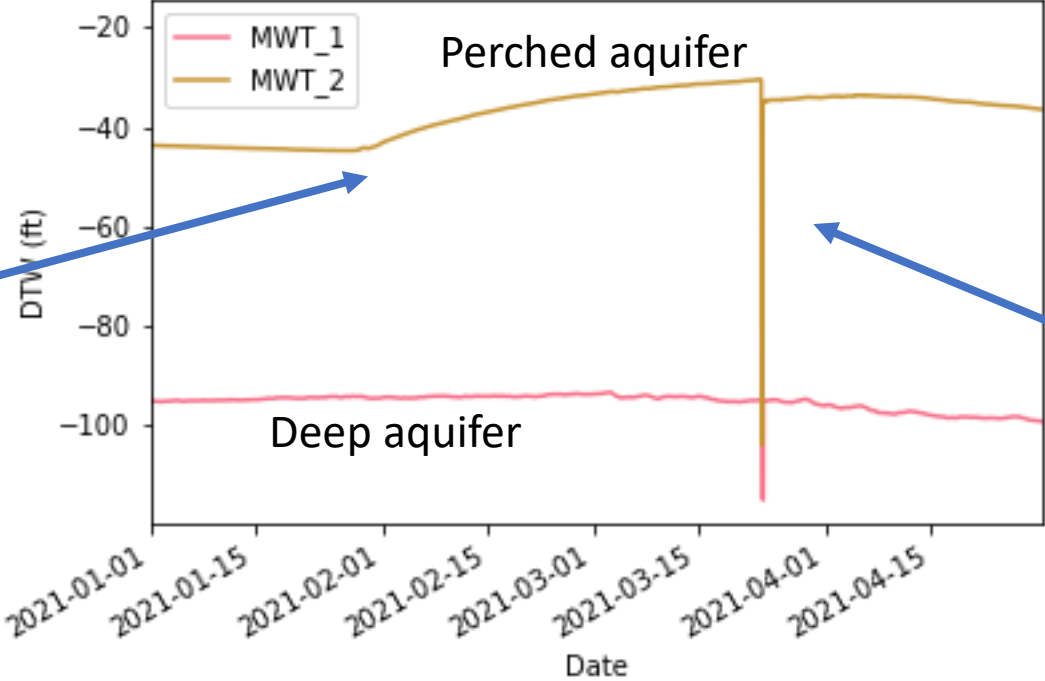


# Site instrumentation

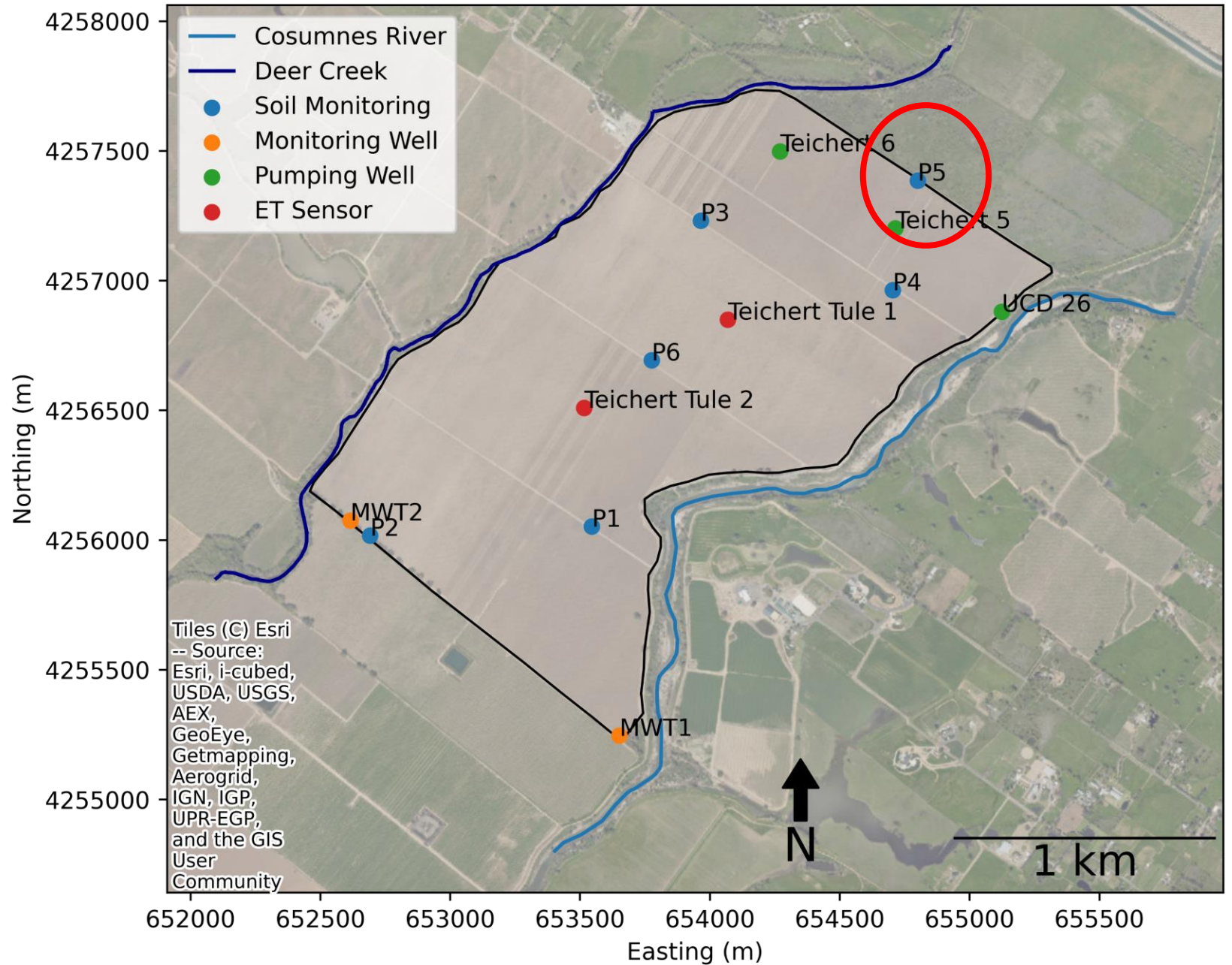


# Deer Creek Flooding - 2021

Recharge  
into  
perched  
aquifer



Water  
quality  
sampling  
event



# Geophysical study results

## - Geophysical study overview

### Site map of recent & continuous data collection locations

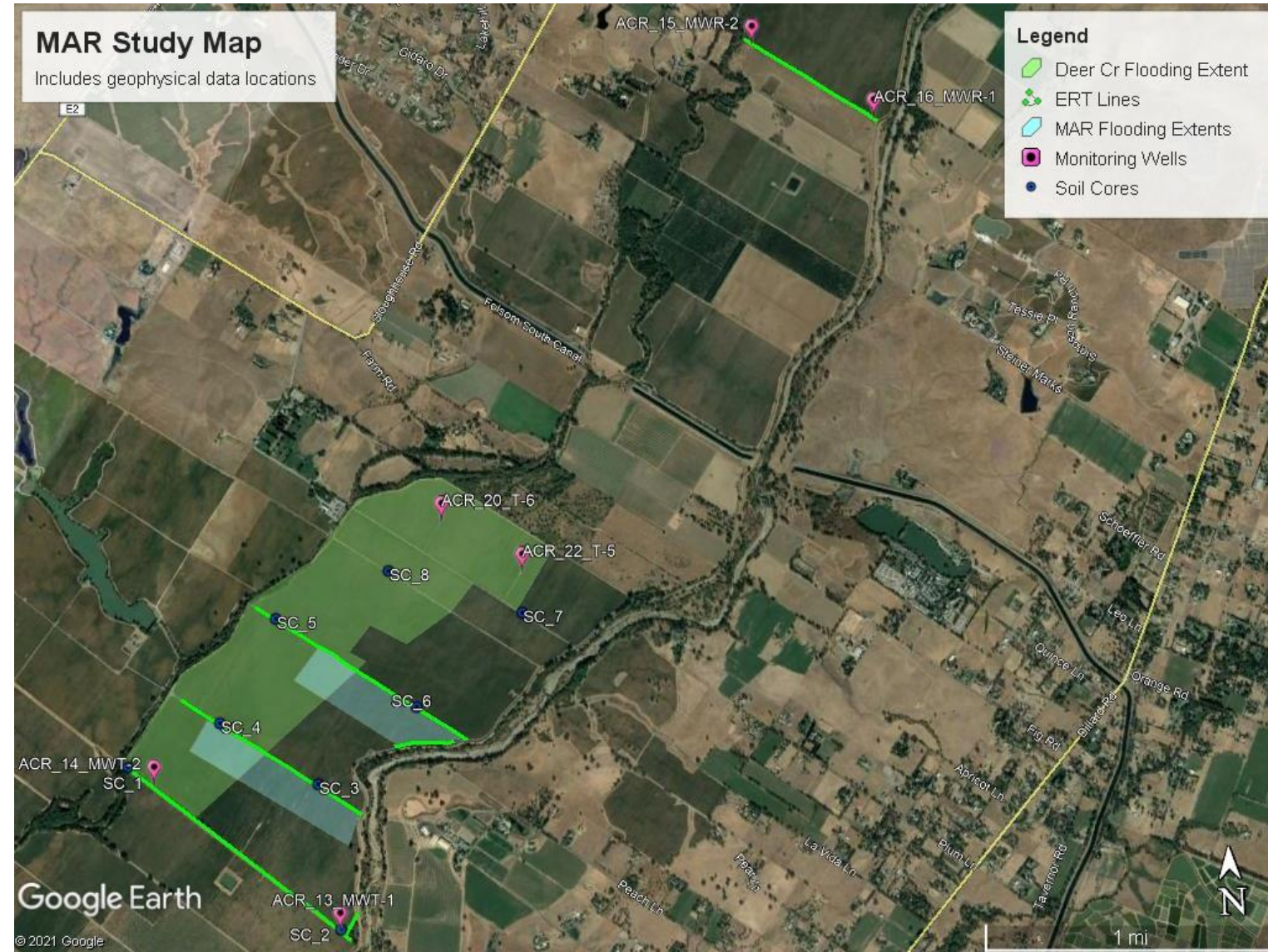
- Collected:

- Borehole geophysics (gamma, induction, & NMR)
  - Tells us how sediments change in lithology and water content continuously down depth in a well
- Electrical Resistivity Tomography (ERT) Imaging
  - Provides a 2-D depth scan along a line on the surface that tells us how changes in lithology vary with depth and along a survey path

- Data collected complement our existing knowledge of:

- Surface hydrology
- Groundwater hydrology
- Lithology (aquifer material)

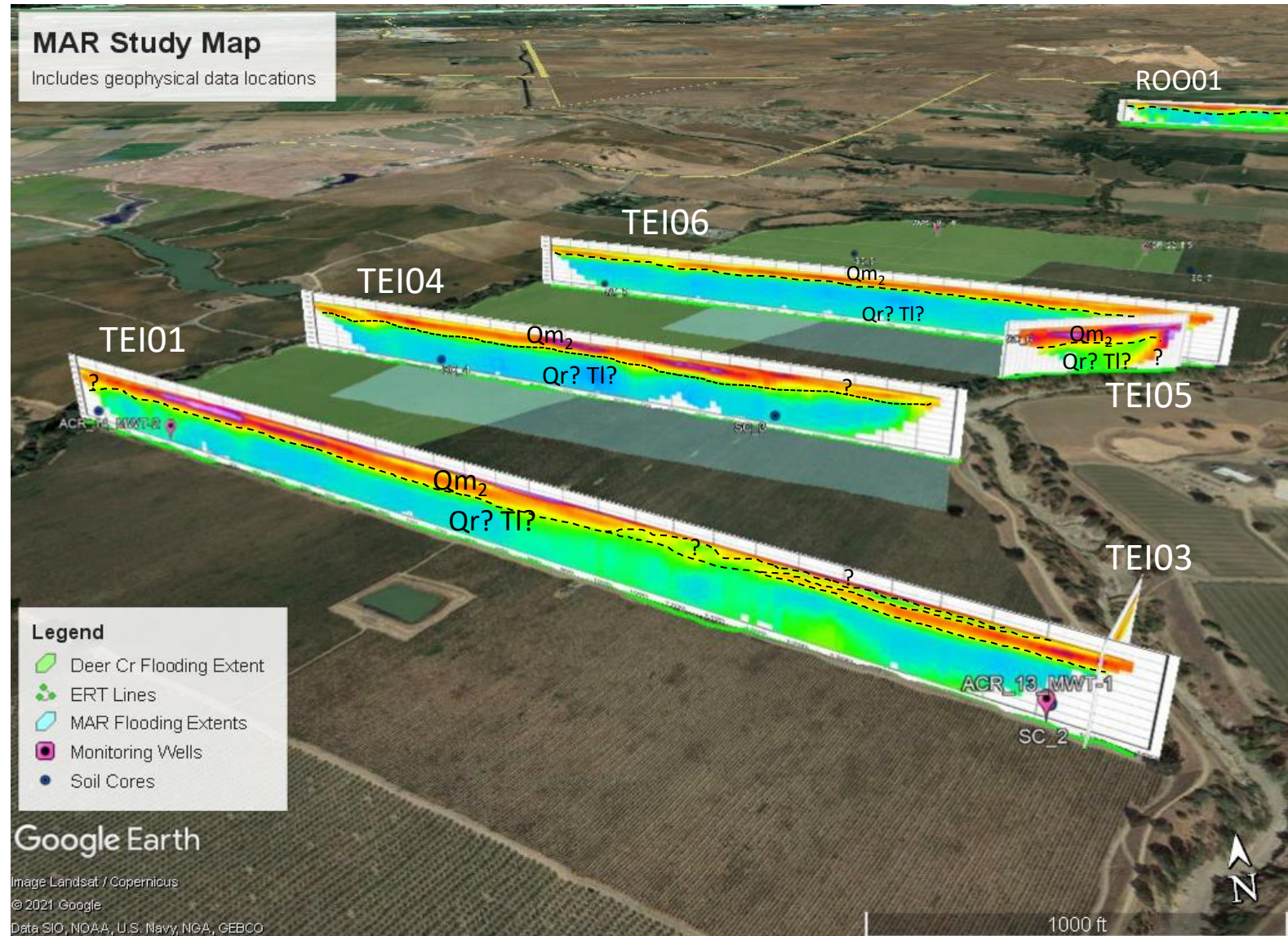
- Helps to understand MAR impacts



# Geophysical study results

## - Surface geophysics (ERT imaging)

- Paleochannels of higher concentrations of sand/gravel present throughout  $Qm_2$
- Natural & artificial flooding, irrigation, and **large paleochannel intersection with modern Cosumnes R. bed** all contribute to recharge throughout different times of the year
- $Qm_2$  hosts perched aquifer that recharges regional aquifer (Qr/TI)
- MWT-2 effectively records perched aquifer (dynamic response to flooding)



# Open Access Geologic Data was Digitized for Use in a Detailed Geologic Model

**ORIGINAL**  
File with DWR  
100 850, 13769

THE RESOURCES AGENCY  
DEPARTMENT OF WATER RESOURCES  
WATER WELL DRILLERS REPORT

No 110325  
State Well No. \_\_\_\_\_  
Other Well No. 2470-B

(1) OWNER:  
Name Great Western Savings and Loan  
Address 1300 Alcatraz St. Sacramento, CA 95814

(11) WELL LOG:  
Total depth 222 ft. Depth of completed well 222 ft.

(2) LOCATION OF WELL:  
City Sacramento Owner's number 4411#2  
Township, Range, and Section Sheldon Hills Sub  
Distance from cities, roads, railroads, etc. South end of Sunrise Blvd.

(3) TYPE OF WORK (check):  
New Well  Deepening  Reconditioning  Destroying   
If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE (check):  
Domestic  Industrial  Municipal  Irrigation  Test Well  Other

(5) EQUIPMENT:  
Rotary  Cable  Other

(6) CASING INSTALLED:  
SINGLE  DOUBLE  If gravel packed

From ft.	To ft.	Dim.	Gage or Well	Diameter of Bore	From ft.	To ft.
0	50	6 5/8	3/16			

Size of shot or well rings: 4x6x6 5/8" Size of gravel:  
Describe joint: Welded collars

(7) PERFORATIONS OR SCREEN:  
Type of perforation or name of screen: None

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.

(8) CONSTRUCTION:  
Was a surface sanitary seal provided? Yes  No  To what depth: 50 ft.  
Were any struts used against pollution? Yes  No  If yes, note depth of struts:  
From 50 ft. to 222 ft.

Method of sealing:  
Work started 1-12-74 by J.P. Cleveland 1-13 to 74

(9) WATER LEVELS:  
Depth at which water was first found: 128 ft.  
Standing level before perforating, if known \_\_\_\_\_ ft.  
Standing level after perforating and developing \_\_\_\_\_ ft.

(10) WELL TESTS:  
Was water test made? Yes  No  If yes, by whom?  
Temperature of water \_\_\_\_\_ gals./min. with \_\_\_\_\_ ft. drawdown after \_\_\_\_\_ hrs.  
Was a chemical analysis made? Yes  No   
Was electric log made of well? Yes  No  If yes, attach copy

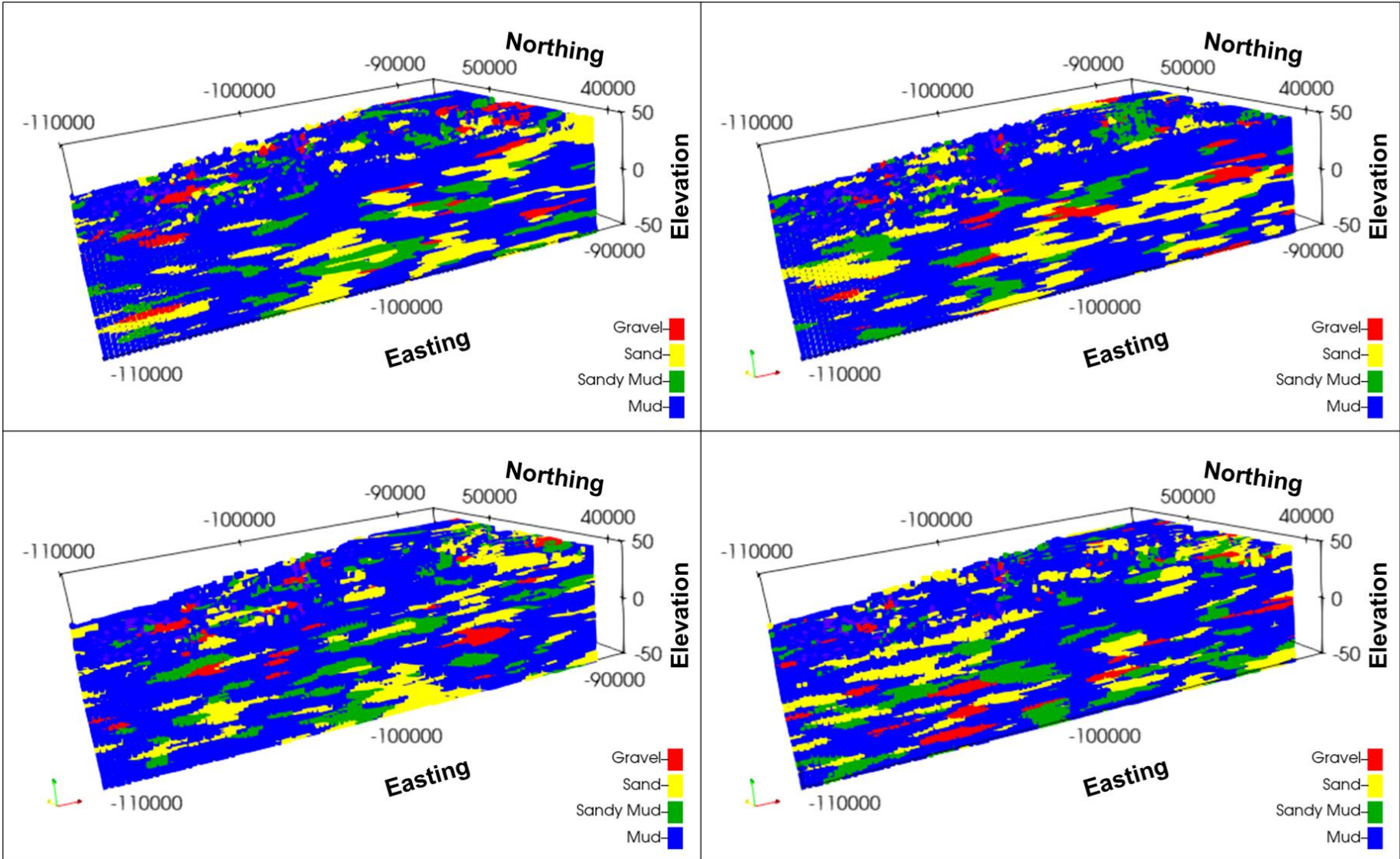
NAME Kyle's Well Drilling  
Address 9500 Central Ave Orangevale, CA 95662  
[SIGNED] Chanton Wells (Well Driller)  
License No. 196723 Dated 2-2 19 74

SKETCH LOCATION OF WELL ON REVERSE SIDE

Unit 2 Lot 71 Sheldon Hills  
Subdivision South end of  
Sunrise Ave across Grantline  
Rd

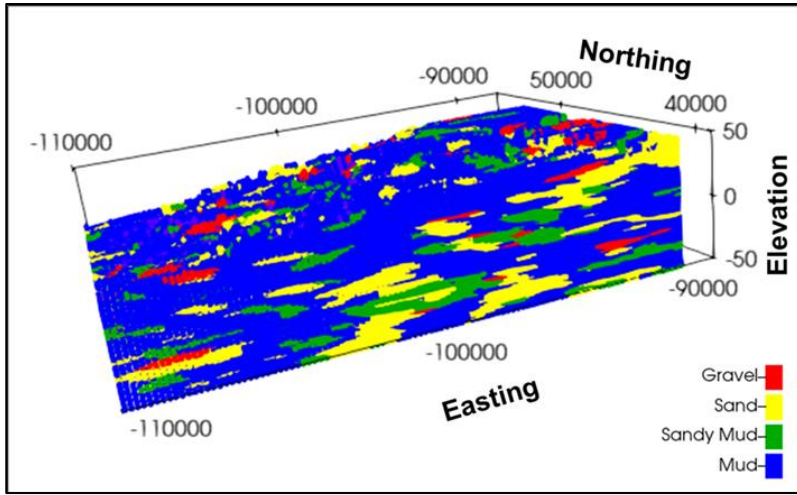
WCR1974-000039	0	3	brown clay
WCR1974-000039	3	11	sand and gravel
WCR1974-000039	11	22	brown clay
WCR1974-000039	22	26	gravel and clay
WCR1974-000039	26	52	brown clay
WCR1974-000039	52	67	gravel
WCR1974-000039	67	80	tan clay and gravel
WCR1974-000039	80	85	brown clay
WCR1974-000039	85	100	tan clay and gravel
WCR1974-000039	100	124	tan clay
WCR1974-000039	124	128	tan clay and gravel
WCR1974-000039	128	146	gravel
WCR1974-000039	146	148	sand and clay
WCR1974-000039	148	152	red clay and gravel
WCR1974-000039	152	162	tan clay
WCR1974-000039	162	175	brown clay
WCR1974-000039	175	179	pink clay
WCR1974-000039	179	200	brown jointed clay
WCR1974-000039	200	209	pink clay
WCR1974-000039	209	216	red brown clay
WCR1974-000039	216	217	sand
WCR1974-000039	217	222	red brown jointed clay

# 100 Versions of the Geologic Model were Created



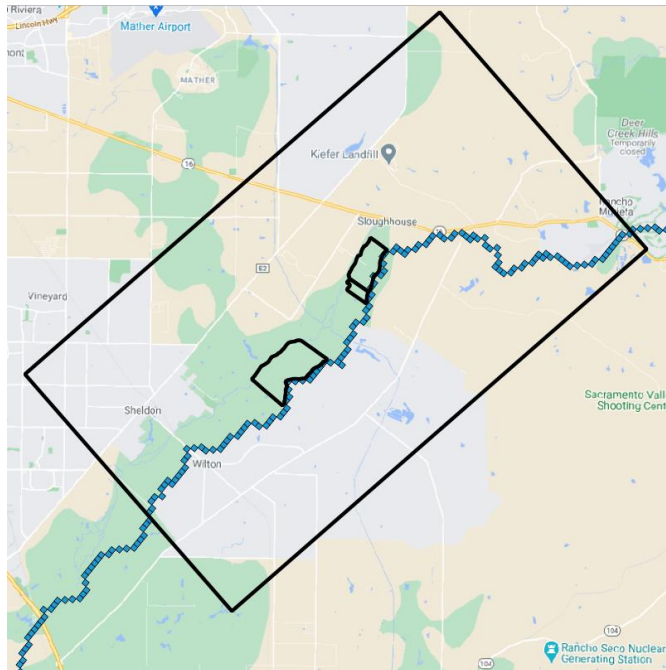
All versions have the same geologic data, but the program adds randomness, which changes the location of connected gravel and sand pathways, which efficiently move water from the surface to the water table





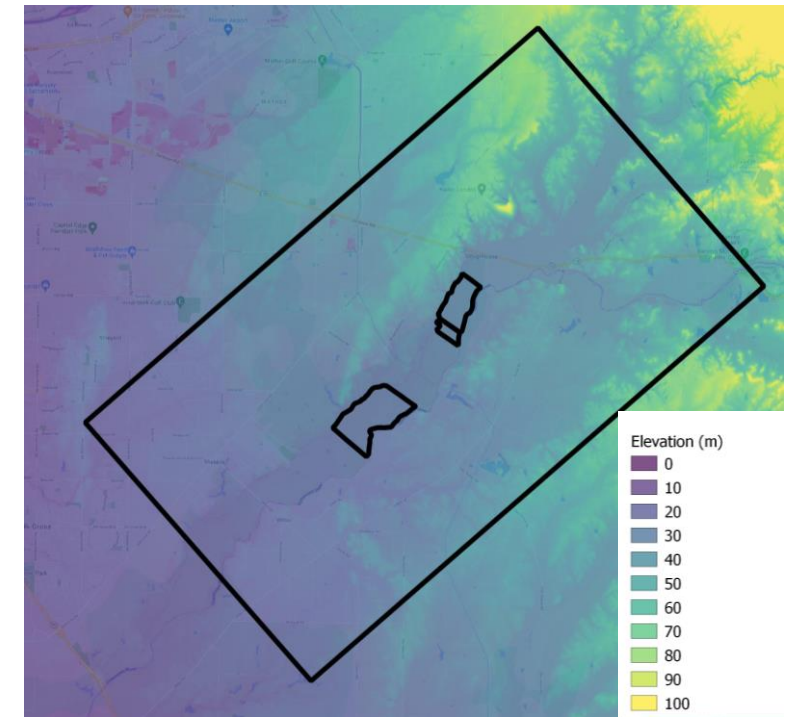
Geology from Geologic Model

### River Seepage

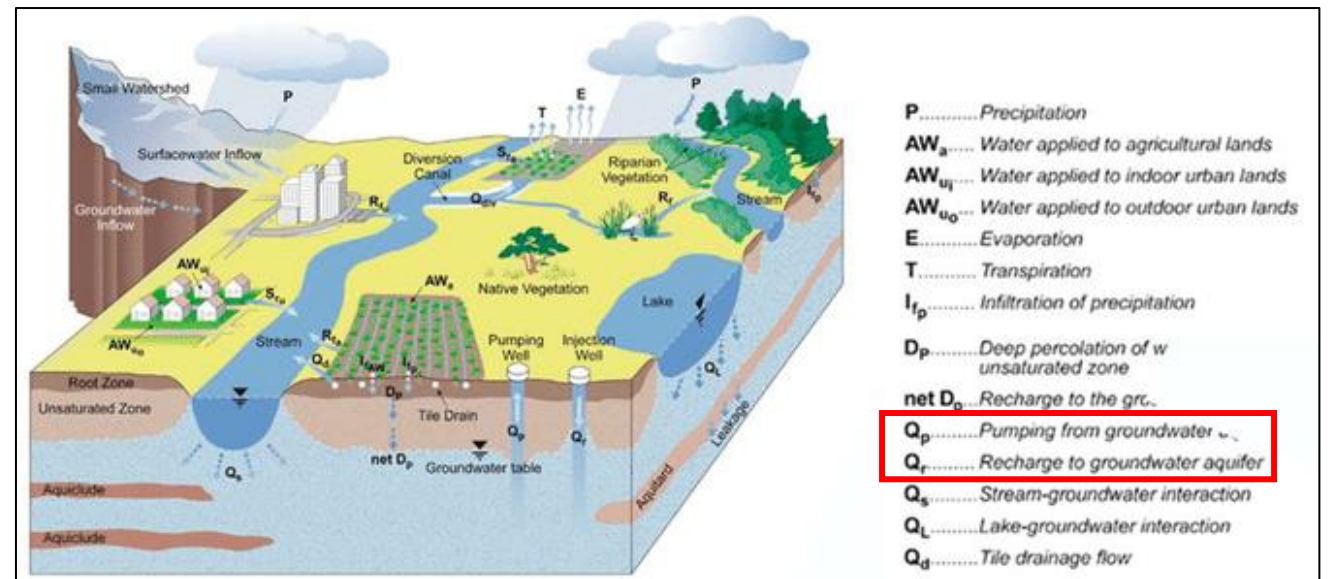


Currently:  
Incorporating  
all data into a  
groundwater  
flow model

### Elevation and Boundary Conditions



### Pumping and Recharge



# External Sources of Funding Also Supported This Project

## Lawrence Livermore National Lab Funding Sources

- University of California “Laboratory Fees” grant (\$300k total)
- Bureau of Reclamation WaterSMART grant (\$200k)
  - Work plan:
    - Task A: Communication and Coordination
    - Task B: On-Farm Recharge Monitoring
    - Task C: River Recharge Monitoring and Modeling
    - Task D: Data Infrastructure and Maintenance
    - Task E: Data Integration and Reporting
- Environmental Protection Agency – proposal due 11/9 (\$2M total)
  - Additional monitoring, isotope tracing, geochemistry modeling

## California State University, Sacramento

- City of Sacramento Water Forum
- Sacramento County Water Agency
- The Nature Conservancy

## University of California, Santa Cruz

## University of California, Davis

- University of California “Laboratory Fees” grant (\$450k total)